What is claimed is:

CLAIMS

1. A configurable integrated optical gate matrix comprising:

a set of nonlinear elements in which a first subset of the set of nonlinear elements is configured to function as a set of ON/OFF switches in the "OFF" state to enable a second subset of the set of nonlinear elements to be configured in at least one optical processing configuration; and

a plurality of waveguides interconnecting at least some nonlinear elements in said set of nonlinear elements.

2. The optical gate matrix according to claim 1 and wherein said set of nonlinear elements is arranged essentially in a parallelogram matrix or a plurality of parallelogram matrices.

3. The optical gate matrix according to claim 1 and wherein said set of nonlinear elements comprises nonlinear elements based on at least one of the following: semiconductor optical amplifiers (SOAs); waveguide devices; and electro-optic nonlinear materials.

4. The optical gate matrix according to claim 1 and wherein said at least one optical processing configuration comprises at least one of the following configurations: a configuration for all-optical 2R regeneration; a configuration for all-optical 3R regeneration; a configuration for wavelength conversion; a configuration for data format conversion; a configuration for demultiplexing; a configuration for clock recovery; a configuration for a logic operation; and a configuration for dispersion compensation.

5. The optical gate matrix according to claim 1 and wherein said at least one optical processing configuration is implemented by at least one of the following configurations:

at least one interferometric configuration;

at least one configuration that enables cross gain modulation (XGM);

at least one configuration that enables four-wave mixing (FWM); and

a combination of at least two of the following: at least one interferometric configuration; at least one configuration that enables XGM; and at least one configuration that enables FWM.

6. The optical gate matrix according to claim 5 and wherein said at least one interferometric configuration comprises at least one of the following: a Mach Zehnder interferometric (MZI) configuration; a Michelson interferometric (MI) configuration; and a delayed interference configuration.

7. The optical gate matrix according to claim 1 and wherein said second subset of said set of nonlinear elements comprises nonlinear element configurations outputting at least some optical signals in essentially opposite directions.

8. The optical gate matrix according to claim 1 and also comprising a controller and driver interface operatively associated with the set of nonlinear elements and operative to provide an interface to a controller and driver for enabling programmable selection by the controller and driver of at least one of the following: a number of nonlinear elements in the first subset; a number of nonlinear elements in the second subset; a distribution of the nonlinear elements in the first subset; and a distribution of the nonlinear elements in the second subset.

9. The optical gate matrix according to claim 1 and also comprising input/output (I/O) ports operative to direct light into and/or out of at least some nonlinear elements in said set of nonlinear elements.

10. The optical gate matrix according to claim 1 and also comprising optical filters operative to direct light at selective wavelengths into and/or out of at least some nonlinear elements in said set of nonlinear elements.

11. An optical processing unit (OPU) comprising the configurable integrated optical gate matrix of claim 1.

12. A photonic device for selectively performing on an input optical signal an optical processing operation and a switching operation, the photonic device comprising:

a first nonlinear element; and

a set of nonlinear elements comprising a second nonlinear element and not comprising the first nonlinear element, the set of nonlinear elements being configured in an optical processing configuration, wherein

the photonic device is controlled to enable performance of the optical processing operation on the input optical signal by the set of nonlinear elements to output an optical processing result to a first output route when the second nonlinear element is turned to an "ON" state and the first nonlinear element is turned to an "OFF" state, and to switch the input optical signal to a second output route by turning the first nonlinear element to an "ON" state when the second nonlinear element is turned to an "OFF" state.

13. The photonic device according to claim 12 and wherein said optical processing operation comprises at least one of the following: all-optical 2R regeneration; all-optical 3R regeneration; wavelength conversion; data format conversion; demultiplexing; clock recovery; a logic operation; and dispersion compensation.

14. The photonic device according to claim 12 and wherein each of the first nonlinear element, the second nonlinear element and the set of nonlinear elements comprises a nonlinear element based on at least one of the following: SOAs; waveguide devices; and electro-optic nonlinear materials.

15. A memory unit for storing optical information, the memory unit comprising:

a controller operative to determine whether the optical information is to be stored for a time period exceeding a threshold or for a time period not exceeding the threshold;

an all-optical flash memory device operatively associated with the controller and operative to perform all-optical flash storage of the optical information for the time period not exceeding the threshold; and

an information storage element operatively associated with the all-optical flash memory device and the controller and operative, if the optical information is to be stored for the time period exceeding the threshold, to receive the optical information from the all-optical flash memory device, and to store a representation of the optical information in a form suitable for storage in the information storage element for an additional time period to reach the time period exceeding the threshold.

16. The memory unit according to claim 15 and wherein the information storage element comprises at least one of the following storage media: a magnetic memory media; an electronic memory media; a magneto-optic memory media; a ferroelectric memory media; a magnetoresistive memory media; an Ovonic Unified Memory (OUM) media; a compact-disc (CD) media; and a digital versatile disc (DVD) media.

17. The memory unit according to claim 15 and also comprising:

a driver operatively controlled by the controller; and

an optical interface operatively associated with the driver, the controller and the all-optical flash memory device and capable of converting said optical information into said form suitable for storage in the information storage element and vice versa.

18. The memory unit according to claim 17 and wherein said optical interface comprises an optical transceiver.

19. An all-optical memory device for storing an optical signal representing optical information, the device comprising:

an optical compactor operative to optically compact the optical signal thereby providing a compacted optical signal; and

an optical memory cell (OMC) operatively associated with said optical compactor and operative to store said compacted optical signal for a period of time.

20. The device according to claim 19 and wherein said optical signal comprises a multiplicity of bits and said optical compactor comprises:

a first coupler/decoupler operative to receive the optical signal and to output NF pattern replicas of the optical signal, where NF is an integer greater than one;

NF optical gates operatively associated with the first coupler/decoupler, each of said NF optical gates being time-delay controlled to output chopped bits of a respective one of said NF pattern replicas of the optical signal at a different time window; and

a second coupler/decoupler operatively associated with the NF optical gates and the OMC and operative to combine the chopped bits corresponding to the NF pattern replicas of the optical signal thereby forming the compacted optical signal, and to provide the compacted optical signal to the OMC.

21. The device according to claim 19 and also comprising an optical expander operatively associated with the OMC and operative to expand the compacted optical signal on retrieval from the OMC thereby restoring the optical signal.

22. An optical compactor for compacting an optical signal comprising a multiplicity of bits, the optical compactor comprising:

a first coupler/decoupler operative to receive the optical signal and to output NF pattern replicas of the optical signal, where NF is an integer greater than one;

NF optical gates operatively associated with the first coupler/decoupler, each of said NF optical gates being time-delay controlled to output chopped bits of a respective one of said NF pattern replicas of the optical signal at a different time window; and

a second coupler/decoupler operatively associated with the NF optical gates and operative to combine the chopped bits corresponding to the NF pattern replicas of the optical signal thereby forming a compacted optical signal representing the optical signal in a compacted form.

23. An all-optical memory device for storage and retrieval of LK optical signals respectively carried over LK separate carrier wavelengths $\lambda_1,\ldots, \lambda_{LK}$ where LK is an integer greater than one, the device comprising:

a first set of LK optical regeneration gates, each optical regeneration gate in said first set of LK optical regeneration gates being operative to receive a respective one of said LK optical signals and an optical-clock (OC) signal at a wavelength λ_{OC}, and time-delay controlled to output chopped bits of the respective one of said LK optical signals over λ_{OC} at a different time window;

a coupler operatively associated with said first set of LK optical regeneration gates and operative to combine the chopped bits corresponding to the LK optical signals to form a compacted optical signal representing a combination of the LK optical signals in a compacted form; and

an OMC operatively associated with said coupler and operative to store said compacted optical signal for a period of time.

24. The device according to claim 23 and also comprising:

a decoupler operatively associated with said OMC and operative to decouple the compacted optical signal, upon retrieval from said OMC, into LK pattern replicas of the compacted optical signal that are each carried over a wavelength λ_{OUT}; and

a second set of LK optical regeneration gates operatively associated with said decoupler, the LK optical regeneration gates in said second set of LK optical regeneration gates being operative to receive the LK pattern replicas of the compacted optical signal and LK optical-clock signals carried over $\lambda'_1,\ldots,\lambda'_{LK}$ and to regenerate said LK optical signals over $\lambda'_1,\ldots,\lambda'_{LK}$.

25. The device according to claim 24 and wherein $\lambda'_1 = \lambda_1,\ldots,\lambda'_{LK} = \lambda_{LK}$ and $\lambda_{OUT} = \lambda_{OC}$.

26. A method for configuring a configurable integrated optical gate matrix that comprises a set of nonlinear elements, the method comprising:

configuring a first subset of the set of nonlinear elements to function as a set of ON/OFF switches in the "OFF" state to enable a second subset of the set of nonlinear elements to be configured in at least one optical processing configuration.

27. The method according to claim 26 and also comprising the step of configuring the second subset of the set of nonlinear elements in the at least one optical processing configuration.

28. The method according to claim 26 and also comprising the step of programmably selecting at least one of the following: a number of nonlinear elements in the first subset; a number of nonlinear elements in the second subset; a distribution of the nonlinear elements in the first subset; and a distribution of the nonlinear elements in the second subset.

29. The method according to claim 26 and wherein said at least one optical processing configuration comprises at least one of the following configurations: a configuration for all-optical 2R regeneration; a configuration for all-optical 3R regeneration; a configuration for wavelength conversion; a configuration for data format conversion; a configuration for demultiplexing; a configuration for clock recovery; a configuration for a logic operation; and a configuration for dispersion compensation.

30. A method for selectively performing on an input optical signal an optical processing operation and a switching operation, the method comprising:

providing a first nonlinear element, and a set of nonlinear elements comprising a second nonlinear element and not comprising the first nonlinear element;

configuring the set of nonlinear elements in an optical processing configuration; and

enabling performance of the optical processing operation on the input optical signal by the set of nonlinear elements to output an optical processing result to a first output route when the second nonlinear element is turned to an "ON" state and the first nonlinear element is turned to an "OFF" state, and switching the input optical signal to a second output route by turning the first nonlinear element to an "ON" state when the second nonlinear element is turned to an "OFF" state.

31. The method according to claim 30 and wherein said optical processing operation comprises at least one of the following: all-optical 2R regeneration; all-optical 3R regeneration; wavelength conversion; data format conversion; demultiplexing; clock recovery; a logic operation; and dispersion compensation.

32. A method for storing optical information, the method comprising:

determining whether the optical information is to be stored for a time period exceeding a threshold or for a time period not exceeding the threshold;

performing all-optical flash storage of the optical information in an all-optical flash memory device for the time period not exceeding the threshold; and

if the optical information is to be stored for the time period exceeding the threshold:

receiving the optical information from the all-optical flash memory device; and

storing a representation of the optical information in an information storage element in a form suitable for storage in the information storage element for an additional time period to reach the time period exceeding the threshold.

33. A method for optically storing an optical signal representing optical information, the method comprising:

optically compacting the optical signal thereby providing a compacted optical signal; and

optically storing said compacted optical signal for a period of time.

34. A method for optically compacting an optical signal comprising a multiplicity of bits, the method comprising:

replicating the optical signal to obtain NF pattern replicas of the optical signal, where NF is an integer greater than one;

generating, from each of said NF pattern replicas of the optical signal, chopped bits at a different time window; and

combining the chopped bits corresponding to the NF pattern replicas of the optical signal thereby forming a compacted optical signal representing the optical signal in a compacted form.

35. A method for enabling optical storage and retrieval of LK optical signals respectively carried over LK separate carrier wavelengths $\lambda_1,\ldots,\lambda_{LK}$ where LK is an integer greater than one, the method comprising:

generating, from each of the LK optical signals and an OC signal at a wavelength λ_{OC}, chopped bits over λ_{OC} at a different time window; and

combining the chopped bits corresponding to the LK optical signals to form a compacted optical signal representing a combination of the LK optical signals in a compacted form for storing said compacted optical signal for a period of time.

36. The method according to claim 35 and also comprising:

decoupling the compacted optical signal upon retrieval into LK pattern replicas of the compacted optical signal that are each carried over a wavelength λ_{OUT}; and

regenerating the LK optical signals over $\lambda'_1,\ldots, \lambda'_{LK}$ from the LK pattern replicas of the compacted optical signal and LK optical-clock signals carried over $\lambda'_1,\ldots, \lambda'_{LK}$.